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ABSTRACT

As the scholarly record has grown, so have bibliographic control instruments, some of which are in machine readable form. The expense of setting up an organization for access to the machine readable data bases seems beyond the budgets of most institutions. The objective is to establish a dependable service organization to make machine readable data bases available to researchers. MERIT has promulgated the objective to make machine readable data bases accessible to its members. The sharing of competences and facilities will make it possible to establish a service to MERIT institutions collectively that cannot be established separately. This expansion of the MERIT network will make demands on resources and facilities of its members, but in the long run the institutional objectives will be better served. This program will further develop expertise in the planning and development of network goals and not merely represent the interest of the separate member institutions. (Author/SJ)

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Working Paper No. 7

Access to Machine Readable
Bibliographic Data,
a Proposal
to
MERIT

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Detroit

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SUMMARY

Problem. The scholarly record is now so large and diffusely distributed that the individual researcher must take special effort to select what he consumes.

Discussion. As the scholarly record has grown, so have bibliographic control instruments. Some of the agencies producing these instruments have put the content into machine readable form. The data published in this format has the potentiality of being manipulated to produce selected lists of source documents. This potentiality can only be realized if there is software development for searching these tapes and instructions are available to formulate logical statements using the categorical language utilized by the producers of the data bases. If the printed instruments are thought costly, the expense of setting up an organization for access to the machine readable data bases seems beyond the budgets of all but the very rich institutions.

The objective is to establish a dependable service organization to make machine readable bibliographic data available to researchers.

Method. The data bases can only be "read" through electronic equipment. The speed with which the data can be read makes it feasible to share data bases among several institutions. MERIT has promulgated the objective to make machine readable data bases accessible to its members. MERIT has the administrative structure

1. To purchase the data bases for its members,
2. To share the work of developing the software to make the data bases readable,
3. To assign priorities of activities and monitor expenditures, and,
4. To organize and maintain a continuing education program for the support staff of specialists.

Expected results. The sharing of competences and facilities will make it possible to establish a service to MERIT institutions collectively that cannot be established separately. This expansion of the MERIT network will make demands on resources and facilities of its members, but in the long run the institutional objectives will be better served. This program will further develop expertise in the planning and development of network goals and not merely represent the interest of the separate member institutions.

INTRODUCTION

While the amount of knowledge available to our society is constantly growing, the amount of information an individual researcher can consume has not grown. Benjamin refers to this situation of the "twigging phenomenon" which can be described as

the continual fractionation of knowledge and of scholarly research. Naturally, this endless fractionation results in hundreds of highly specialized books being written every year for groups of readers who are no larger in number today than they were 30 years ago--this despite the fact that our total population of research scholars has almost doubled in each of the last three decades. In short, the specialists need and write books on proliferated and refined subjects...
(1)

The individual researcher cannot increase the amount of information he consumes by extending his day. He can only try to be efficiently selective. Selecting from large masses of literature is time-consuming and changes have occurred in his work environment which compete for his time. Individuals starting research careers in 1937 have observed a 40-fold increase in expenditures for scientific research and development (2) and have watched academic institutions grow into large bureaucratic organizations.

1. The institutional base in which a researcher must work is large even if his specific administrative assignment is to a small department, institute or center. Nearly every active researcher has to be involved with committee work within his institution to keep the decision-making process operating.
2. The same proliferation of communication responsibilities has occurred in the professional and scholarly organizations to which the researcher must belong. These organizations have communication bureaucracies to keep up with growth in size that reflects the same complexities as the institutional base in which the researcher works.
3. The source of funding for investigative work has moved from the institution in which the researcher works to outside agencies. Another complex of institutions and bureaucracies has become part of the scholar's communication structure.

(1) Benjamin, D. B. The American Scholar. 41:212-221, Spring, 1972.

(2) Woodrow, R. J. Government-University Financial Arrangements for Research, Science. 176:885-889, 26 May 1972.

The way the primary scholarly record is produced and disseminated has not altered for the past 100 years; that is, new technology may be employed to reproduce books, but the intellectual work of selecting documents for publication, the distribution techniques used, and the methods of institutional storage and retrieval of documents have remained about the same.

The researcher in the 1970's has to be a part of several multifaceted organizations. To restate: The researcher's day has not increased in length nor has he become a superman in which he can absorb any more information per day than his predecessors. His only recourse in this enriched (if not engorged) environment is to develop a sense of wisdom in selecting what is important for him. This paper is directed toward investigating the possibility of developing an organization which can aid the researcher in selecting the information he needs from the scholarly record through the use of computer technology. What must be emphasized is that the intellectual effort is the same whether computer technology is used or not, but to maximize the use of computers for this purpose requires (i) that our existing institutional structure for bibliographic control and retrieval be reordered or (ii) that a new kind of organization be created.

Computer Technology and Bibliographic Control. The institutions and agencies responsible for keeping the scholarly record under bibliographic control have rarely been able to handle the output on a dependable scheduled basis--backlog of materials to be processed were part of normal operating procedures. With the growth of research and development the time pressure on researchers to identify and retrieve documents also grew. Backlogs which were considered a nuisance became intolerable. The National Library of Medicine took the lead in the 1950's in utilizing computer technology to alleviate the backlog problem in the physical production of INDEX MEDICUS. Several other agencies have since put the results of their intellectual work of bibliographic control of the scholarly record into machine readable form to aid in the printing and distribution of bibliographic instruments. Because computers are able to manipulate data with such rapidity, possibilities of printing different kinds of arrangements of bibliographic control elements are possible. More recently because of the advancement in technology, computer data bases of bibliographic elements can be queried directly.

The speed with which a computer can manipulate data has misled individuals into thinking that automated bibliographic retrieval has resulted in new methods of bibliographic controls. This is not the case. The way the scholarly record is produced, and hence identified, evolved from a social environment that has not changed in any essential way since the 19th century. All the techniques of bibliographic controls available today were identified or "invented" by the 20th century. The number of elements to characterize the documents of the scholarly record are few:

1. The author or the responsible agent,
2. The title or description the author gives to his work to distinguish it from his other work and documents produced by others,
3. The publisher of the document which in some cases is itself a title, for example, a journal,
4. The date of publication, and
5. The place of publication.

When the segment of the scholarly record to be brought under control is small, not all the above elements are needed. For any large segment all these descriptive elements are required and perhaps additional ones if the same document is published in different formats. Given the above five elements, all but a few documents out of the hundreds of millions of documents still extant, can be identified. Although these elements can distinguish any document from any other, the control of the scholarly record is considerably more complex. The storage of documents, if the number is small, can conform to one of the above elements. Large collections, however, must have some categorical scheme that goes beyond these five elements for efficient retrieval.

Scholars and taxonomists have tried to create universal categorical schemes that could place all knowledge into one system, but the scholarly record can be organized (so far) only through the use of language. A universal system is therefore not possible because "sentences that mean one thing in one universe of discourse may mean something very different in another, and sentences that are ambiguous in a particular language may not be ambiguous in a restricted subset of that language." Although no perfect system has been devised, two general approaches have evolved in categorizing the informational content of the scholarly record.

1. The natural contemporary language. Words from the document being categorized are taken from the title and arranged in a listing tied in some way with its bibliographic description. The 19th century German indexers referred to these words as Stichwörter. If a title proved unsatisfactory from which to select Stichwörter, then the indexer would create a title that would characterize the work. Such words were called Sachwörter. Anyone using a listing formed from contemporary language would have to know all synonyms and changes in meaning of these "keywords". Operationally the number of keywords to characterize a

(2) Bross, I.D.J., Shapiro, P.A., and Anderson, B.B. How information is carried in scientific sub-languages. Science 176:1303-1307, 23 June 1972.

document has to be limited in preparing a listing because of the expense of compiling and printing the list. The computer has removed some of these constraints. The keywords in a title, or even an abstract of a document, if in machine readable form, can be sorted and printed automatically. Further, with an on-line access to such a data file, combinations of keywords can be formulated and the file searched. Such "coordinate" searching of keywords can be done from printed lists, but the work is so tedious that only the highly motivated will undertake this kind of search.

2. Controlled language. American bibliographers and indexers felt that the keyword approach to identifying documents was imprecise. Two methods were developed. Classification schemes were devised with an alphabetic and/or numeric notation, for example the Dewey Decimal Classification. An index of terms defines and delimits each classification number; that is, keywords are used as an index to a fixed notational scheme. The other method is to create a limited vocabulary to categorize documents. A cross reference system of synonyms and variant meanings is then prepared again to define and to delimit the words used to categorize documents. The same kind of constraints exist in using a controlled language as with a keyword approach if the bibliographic instrument is printed.

In the remainder of the paper these methods of controlling the scholarly record will be referred to as the use of categorical languages.

Institutionalization of bibliographic control. The above discussion suggested that computer technology expands the dimensions of bibliographic control. What must be emphasized is that although computer technology can improve control of the scholarly record, the improvement is only in the speed of manipulating bibliographic elements and categorical language. The use of the adverb only is not meant to be remonstratory, rather to stress the fact that the exploitation of computers for bibliographic control has to be accomplished within a structure.

The production of the scholarly record is a complex enterprise because it is used while it is being produced; that is, the production cannot be described in a sequential flow chart. (3) The first element that must be taken into consideration is that the scholarly record is a public record. Because of the size of the scholarly record, its storage and accessibility requires an organization that is administered by others than those who produce the scholarly record. As noted above, the identification of individual documents cannot be separated operationally from their storage. Institutionally the storage of documents is the social responsibility of libraries. Although all libraries must produce their

(3) Orr, R. N. and others. The biomedical information complex viewed as a system. Federation Proceedings 23:1133-45, Sept.-Oct. 1964.

own bibliographic control instruments, e.g., card catalogs, to accomplish their storage responsibility, the production of the instruments is not done entirely in libraries; professional societies, government agencies, and commercial agencies undertake the production and distribution of control instruments for various segments of the scholarly record. Research libraries must make their own bibliographic instruments consistent with, or at least relate to, those instruments which are produced by outside agencies. Research libraries have a staff whose responsibility is to interpret bibliographic control instruments to library users and to assist in locating and retrieving documents. The quality of this service function varies considerably among libraries and in the same library system over time. Libraries have been able to "get by" with undependable quality control of such services because the bibliographic control instruments are in print form. The individual who must use them can, if sufficiently motivated, learn how to exploit them through study of their format and following instructions. Bibliographic control data that are in machine readable form cannot be made accessible through this self learning process except if maintained on line. If machine readable bibliographic data bases are to be used to any extent in academic environments, then it would appear that some mediated service organization is required.

PROBLEM

Table 1 lists the major (i.e., largest in number of citations included) bibliographic control services that now market machine readable bibliographic data. These tapes besides being a different format of publication are in most instances, but not all, either by-products or preliminary to the production of printed bibliographic control instruments. For example, in the preparation of the Psychological Abstract tapes a controlled language of descriptors is used for categorizing citations for the printed copy. But the design of the system permits the possibility of a coordinate search of the keywords in the titles of the citations--a procedure that is all but impossible to do with the printed copy. To accomplish such a search requires considerable software development. What is perhaps least appreciated about the issuance of bibliographic data in machine readable form is the necessity of an institution setting to read the data.

Table 1

Machine readable bibliographic data bases available July 1972

<u>Name of service</u>	<u>Price per year</u>	<u>Frequency of publication</u>	<u>No. of journals indexed</u>	<u>No. of citations per year</u>	<u>Keyword vocabulary</u>	<u>Controlled vocabulary</u>	<u>Printed copy generated</u>
SPIN (American Institute of Physics)	\$2500	Monthly	73	13,000	yes	yes	no
BA Previews (Biological Abstracts)	5000*	3/month	8,000**	55,000	yes	no	yes
Chemical Titles (American Chemical Society)	2160*	bi-weekly	700	12,000	yes	no	yes
CA Condensates (American Chemical Society)	5130*	weekly	12,000**	30,000	yes	no	yes
COMPINDEX (Engineering Societies)	6800	monthly	3,500**	72,000	yes	yes	yes
Psychological Abstracts (American Psychological Association)	3000	quarterly	800**	92,000	yes	yes	yes
ERIC	520	quarterly	500	30,000	no	yes	yes
Government Reports Announcements	1500	bi-weekly	?	11,000	yes	yes	yes

* Includes subscription to printed issues with cumulated indexes.

** May also include books, reports, dissertations, etc.

1. Cost. The printed bibliographic control instruments as represented in Table I were produced with the expectation that individual researchers could purchase them. The cost of these instruments have now increased so that no scholar can afford them unless he receives some institutional subsidy. In all but a few instances the instruments must be purchased for multiple use. The tapes are even more expensive.

2. Readability. Unlike the printed product, the tapes must have expensive equipment to read them. Rarely is the equipment under the control of the reader. Computing equipment has become so intricate that a separate organization must exist to make it accessible. The multi-use of most computing facilities do not make it possible for the support staff to respond to users' schedules in setting up (and storing) tapes. Even in the situation where the data is kept online, dependability of computer systems are still not ideal. Again cost is a significant factor: to use the tapes requires not only equipment, but an intermediary support staff.

3. Computer languages. Most machine readable bibliographic data bases are compiled to improve the efficiency of producing a printed copy. The programs prepared for this purpose have limited use for manipulating data to produce arrays other than that used for printing. To take advantage of the potential for manipulating data, those who purchase these tapes must prepare their own programs as well as undertake the task of making the tapes "readable" on their own equipment. This is not, unfortunately, a one-time investment. The producers of the tapes may change their programs to increase their efficiency or to adjust to new or different electronic equipment. This in turn means those who purchase the tapes must make adjustments in their programs for utilization. Although standardization of equipment (and software) seems to be developing, computing facilities have not yet arrived at such a stable configuration of equipment that all the programs used within its own shop never need alterations much less be able to automatically adjust to changes of assigned space in a data base produced in another facility. The management of a computer memory requires a skilled staff that has continuity--computer instructions are so complicated that programmers are often baffled when they look at programs they have written but not have seen for several months, and a third party usually finds them inscrutable. (4)

(4) Software into hardware. Scientific American 226:42-43, Mar. 1972.

4. User-machine interface. A programmer can have an efficient system for the management of the data in a computer memory, but there must exist still another set of detailed instructions to enable the user to communicate his problem to the machine to get an answer. If the data base includes the use of a categorical language, the user can state his problem using this language in a Boolean equation. The computer then searches for the identity in the data base. This would appear to be a relatively simple matter because the user presumably knows how to state his problem, but he may not be able to state it in the subset of the categorical language recorded in the data base. When a user consults the printed form, as noted above, he can approach the file in a pragmatic way, that is to say, he need not have a precise statement in making his search because he can make adjustments as he proceeds. A computer search does not permit changes in logic nor permit intuitive leaps. The search must be given in a logical statement, and more important, for the search to be efficient, the statement must precisely state the problem (in terms of the categorical language used). The larger the data base, the greater the need for precise statements. Librarians as a group have tried to equip themselves intellectually to negotiate problems of users so that either the librarian can do an efficient search in bibliographic control instruments or teach the user how to proceed.

In summary, if researchers are to have access to machine readable data bases, then it will be necessary, because of cost, that the data bases be purchased for multiple use. To extract the data into useable form requires the support of two kinds of specialists, the one who deals with computer language and the other who deals with categorical languages.

ORGANIZATIONAL NEEDS

If the constraint is accepted as realistic that machine readable bibliographic data bases are only practical to acquire if available for multiple use, then a bureaucratic organization is required. Assuming that an organization is to be created to make at least the data bases listed in Table I available what are some of the factors that must be considered?

The first factor to be settled is for whose convenience should the organization be created. While the answer would appear to be obvious, operationally the objectives may not be clear. A bureaucracy exists to provide products or services that are used by other than the members of the bureaucracy. In a situation as described here where activities of different groups have to be coordinated within an institution and among institutions, territorial "rights" can be usurped which results in an organization that exists for itself rather than fulfilling objectives external to itself. Each of the data bases requires different sets of competences to utilize; the tendency may be to develop an organization which serves the disciplines as they exist administratively. If a service is to be established which supports the needs of the information consumer, then it must be recognized that these massive data bases are of interest to consumers that are not easily assigned to an administrative categorization; for example, the chemical bibliographic data bases are of use not only to researchers in a chemistry department, but to physicians, engineers, biologists,

physicists, and others. The service organization therefore must be designed so that users view it as accessible without having to belong to a specific discipline or administrative department. If the idea is accepted that an organization is needed that can incorporate needs of a multidisciplinary group of users, then it appears reasonable that communication channels for the user (that is the consumer) to plug into the organization should be as simple as possible.

Starting then from users who as individuals represent many disciplines, a maximum use of machine readable data bases requires that someone can either interpret categorical languages for the user or that some mechanism be set up so the user can learn the languages. The latter approach, if experience is any guide, is not suitable because getting busy researchers together to teach them what they think they already know appears to them as patronizing. Whether this subject specialist, this translator of the categorical languages, is a librarian, as suggested above, or some other trained subject specialist is of minor consideration. What is argued here is that the subject specialist should be located within a library:

1. These data bases consist of bibliographic citations; to get the documents relating to these citations requires a library system to retrieve.
2. Libraries are part of a system with which all researchers are acquainted; politically speaking, libraries are neutral in that their services are designed for multidisciplinary groups.
3. In "negotiating" a problem with a user for formulating a machine search, it may be determined (i) that the information wanted is already available in print in a useable format (e.g., a reference book), (ii) that the question can be answered without a machine search, i.e., the citations can be more conveniently retrieved from printed sources. (5)
4. Although a user may be acquainted with one data base, it may not be the most suitable data base to answer his problem; if subject specialists are all located in libraries, the task of referring problems becomes administratively simpler.

(5) It should be noted that other machine readable data bases exist than bibliographic citations, for example, census data, which may not require a machine search to answer a question since it may be published in some other format than tapes.

5. Information on the changes that occur in categorical languages can be secured in places other than libraries. however, research libraries do collect materials that can support the subject specialist in keeping himself informed.
6. Libraries may not be organized any better than other units in an academic environment to maintain cost accounting procedures for mediated services as proposed here, but libraries do have procedures for tabulating and counting transactions of this type.
7. Libraries purchase printed bibliographic control instruments; since some of the subscriptions to machine readable data bases are tied to the printed form, the library is equipped to order and process the acquisition of this kind of publication also.

Irrespective of where the subject specialist is located, he cannot interpret the possibilities and limitations to the user of the machine readable data bases without some knowledge of the work of the computer language specialist who designs the retrieval programs. Could the subject specialist and the programmer be the same person? Theoretically, yes, but practically, no. The task of keeping abreast of computer languages requires that programmers be in a special work environment. Similarly the subject specialist would have the same difficulty keeping informed about the categorical languages if separated from source documents. Even if such a paragon of competence could be found, as the service develops, the natural tendency would be to add staff with one or the other specialty. Without such specialization, there would be no need for a bureaucracy--each user would have to learn how to deal with both language groups.

If this describes what must occur to establish a dependable access service to machine readable data bases, and if the service is to be given in an academic institution, there is no unit within the usual academic environment that can take on the administrative responsibility for the service. There are but two possibilities: (i) a new administrative unit be created that is independent of existing units, or (ii) a shift in priorities and prerogatives be forged which permits existing units to work toward accomplishing common objectives. The administrative structure can be further complicated if the access service is designed to use the competences and facilities of more than one academic institution--a requirement if efficient utilization of computer facilities is to be accomplished.

The introduction of technology in an agency changes work relationships which in turn has effect on objectives. The fear of administrative change is as real for academicians as it is for assembly line workers. Technological changes are acceptable on a hypothetical basis, but not in relation to an individual's own workplace. Administrative structures follow communication channels; authority and responsibilities are defined on the basis of the way information flows. The following are the minimal points of information transfer for the service organization proposed here:

1. The users (who may have different levels of competence to express their problems in categorical languages need contact with subject specialists
2. The subject specialist will have to be cognizant not only of the categorical languages but also on the instructional language for formulating searches; as data bases are put on-line, the need for consultation with programmers may perhaps diminish, however scheduling of access time to computers has to be established according to users' needs--input-output schedules have to be devised if the service is to be made dependable.
3. The programmers must have knowledge of the programs of those who produce the tapes to translate the procedure of searching into instructions for use by the subject specialist. The programmers must inform and be informed by three groups, (i) the producers of tapes, (ii) the managers of the computing facility with which they are associated, and (iii) the subject specialists.
4. A fourth person(s) has to exist to make this "automated" access service to a third of a million citations dependable--the inevitable administrator. Someone has to see to it that (i) staffing is continuous, (ii) funds for the operation are available, and above all, (iii) the work of the separate specialists are coordinated.

Although there are individuals who have the competence to undertake the above tasks in our academic institutions, they are scattered in many administrative units. As individuals they may know one another, but are not able to form a group to obtain recognition to permit the exploitation of these machine readable data bases. What is needed is leadership in planning an organization and then implementing the plans.

An attitude of our culture seems to pervade our thinking that the first requirement in creating a new organization is money. With money "someone" then proceeds to buy the necessary staff and equipment. We delude ourselves in thinking that our existing organizations will somehow evolve to incorporate the new. The end result is an ever larger bureaucracy. Our society is rebelling--we are realizing continuous growth through accretion of institutions may no longer be a viable approach. (6) This polemic on contemporary society is meant to emphasize that our academic institutions cannot expect to find massive sources of "outside" funds to add new administrative units, particularly for functions which support their own purposes. The technology is available to improve access to information in innovative ways, but to utilize this technology means (i) scholars and researchers will have to change some of their work habits in securing information, (ii) libraries will have to expand the competence of their subject specialists and will have to provide a different kind and quality of document delivery, and (iii) computer centers will have to incorporate into their operations the management of data bases for multiple access. Scholars and researchers cannot change their work habits until there is a dependable organization of which to construct habits. The responsibility therefore lies with libraries and computing centers to form a dependable service organization.

It cannot be emphasized enough times that the competence and facilities are located at Michigan academic institutions to provide an access service to the machine readable bibliographic data bases listed in Table I. Because of organizational and funding problems not any of the data bases are searchable dependably from any Michigan institution although the CA Condensates, ERIC, and the census data tapes are already on location. Desultory experimentation with other data bases has been accomplished at one or the other of the MERIT members.

MERIT has promulgated the objective to make data bases located at one of its members accessible to its other members. The machine readable bibliographic data bases are certainly of the type that can be shared. If the mechanism cannot be found to share these data bases then the only alternative would appear to be for each of its members to invest their capital into establishing and maintaining parallel computer services. Either alternative requires commitments by each member of MERIT that are neither insignificant nor transient.

(6) Gallant, J. A. and Prothero, J. W. Weight watching at the University, the Consequences of Growth. Science 175:381-388, 28, January 1972

The theme this paper has been trying to elicit is that through the sharing of competences and facilities innovative service can be provided the members of MERIT that cannot be provided if each must work independently. Sharing of resources and utilizing them to attain common goals will result in conflict with the separate member's value system of priorities. Conflicts can be resolved into productive output if it is accepted that resolving them will result in benefit to the member institutions. MERIT institutions are confronted with administrative and logistic problems with information transfer. The problems can only be solved by coordinated, planned, disciplined examination of possibilities and then testing the consequences of various choices. The task can be accomplished if MERIT members are willing to deviate from the familiar and known. Operationally what must be developed is

1. A group of individuals applying specialized knowledge or using specialized skills,
2. A system of rules to assure that the output of the specialists is related to accomplishing the objectives of the organization,
3. A hierarchy of authority (a) to insure the stability of work environment and (b) to provide a mechanism for communicating both intra- and inter-institutionally, and
4. A degree of impersonality of attitudes to permit the organization to gain its identity separate from any one individual or any group within the organization.

The above are abstractions about a potential organization. More directly, what actions can be taken immediately to get the organization started?

1. The tapes must be purchased because software development cannot start until the material is available. (At present the cost of the tapes in Table I are about \$17,000 per year; they are bibliographic instruments; even though they cannot be read at present, MERIT member libraries collectively, if there is no other source of funds, must have these source documents just as they collect other source documents).
2. The responsibility for software development be distributed among MERIT members.

3. Subject specialists be identified who can begin to devote time to gain the competence to formulate searches using categorical language of the machine readable data bases.
4. An advisory committee be established at each MERIT member institution with the charge to provide input to MERIT to define the operational necessities to create a stable organization.
5. A MERIT representative be assigned the task of describing (and then monitoring) the funding requirements.
6. MERIT establish workshop-seminars of specialists involved to encourage the development of an attitude of concern that overshadows the more limited institutional perspective.